Operation Trebuchet: Efficiency of the Floating Arm

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Outline

- Background Information
- Theory & Diagram
- Applications
- Experimental Results
- Discussion & Conclusions
- Future Work

Background

- Trebuchet
  - Uses falling mass
  - Floating-arm configuration

- Calculate efficiency
  - Based on distance thrown

Model

- Converts potential energy to kinetic energy

$$E_k = U \qquad \frac{1}{2}m_2v^2 = m_1gh$$

- Projectile motion after launch

$$x = v\,cos(\theta)t \qquad y = v\,sin(\theta)t - \frac{1}{2}gt^2$$

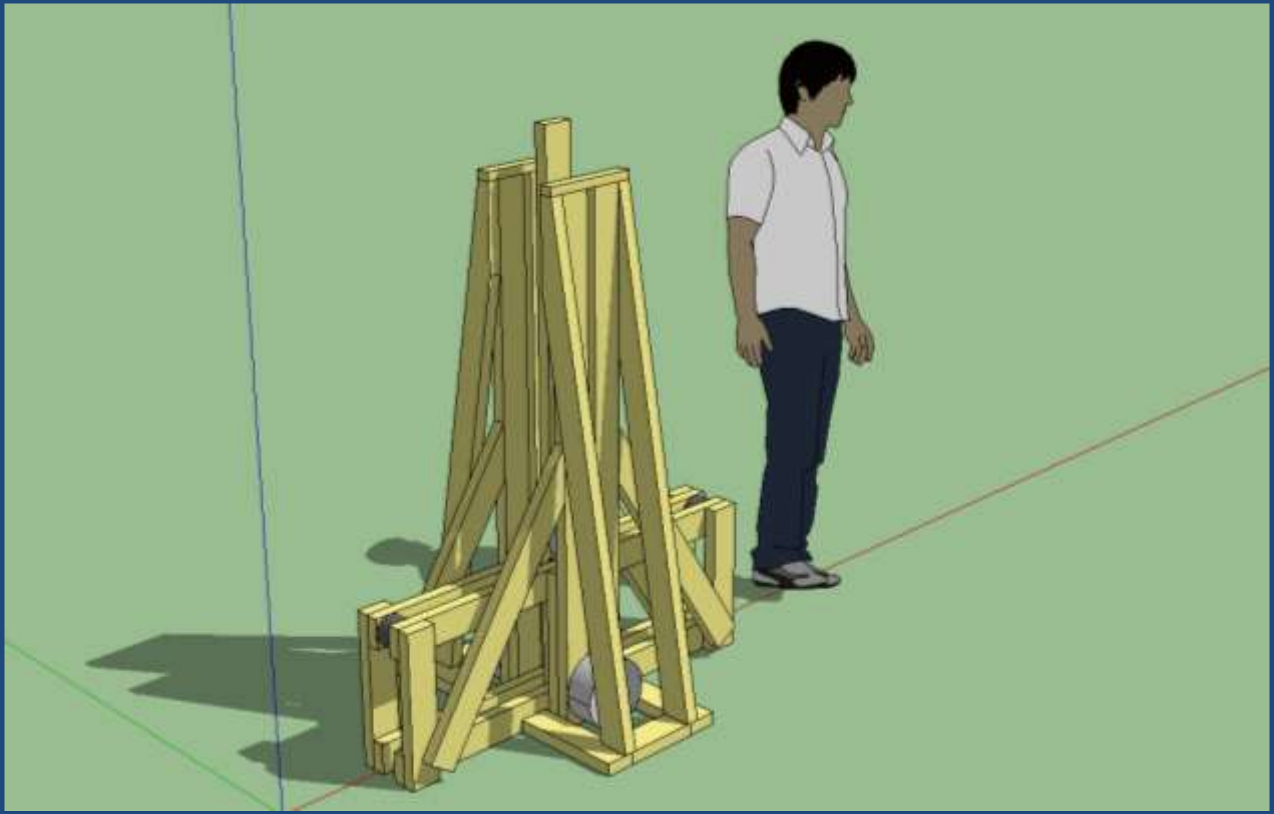
- Derivations yield

$$x = \frac{2m_1h}{m_2}$$

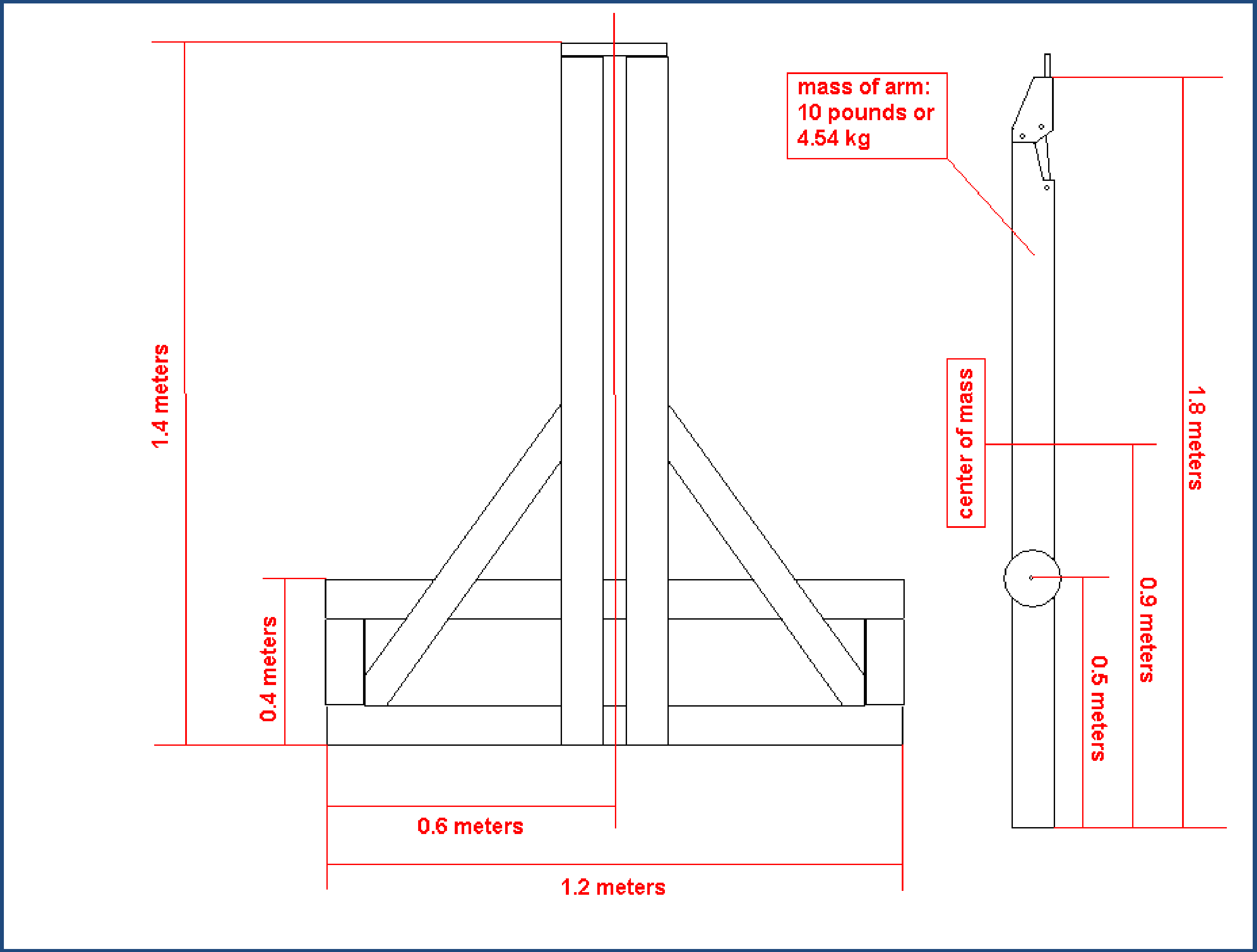
- To calculate efficiency

$$\frac{Actual}{Theoretical} \times 100$$

Physical Model Sketch



Physical Model Dimensions



Application

- Efficiency now known
- Develop more efficient trebuchets
  - Less friction
- Base to verify physical equations

Results

Mass	Trial					
	One	Two	Three	Four	Five	Average
22.26 kg	22.6 m	35.7 m	20.1 m	N/A	N/A	26.1 m
24 kg	33.5 m	39.6 m	34.1 m	32.9 m	38.7 m	35.8 m
26.2 kg	39.6 m	37.5 m	32.9 m	37.8 m	N/A	37.0 m

Results (cont.)

Mass	Theoretical Value	Actual Value	Efficiency
22.26 kg	338 m	26.1 m	7.7 %
24 kg	365 m	35.8 m	9.8 %
26.2 kg	398 m	37.0 m	9.3 %

Discussion

- Very low efficiency
- Greater mass = farther distance
- Unreliable launches affect results
  - Misfires
  - High variability

Conclusion

- Majority of energy used up
  - Overcome friction
  - Air resistance
  - Rotational energy of the arm

- Reduce friction/surface contact
  - Would yield greater efficiency

Future Work

- Create a more efficient trebuchet
  - Reduce friction
  - Lower mass of throwing arm
- Use a heavier projectile
  - May allow for more consistency
  - Also may be more efficient